



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No. : 10/715,825 Confirmation No. : 3647
Applicant : Peter Derek DANIELS, et al.
Filed : November 19, 2003
TC/A.U. : 3744
Examiner : Unknoww
Docket No. : 038871.52947US
Customer No. : 23911
Title : REFRIGERATOR AND NECK TUBE ARRANGEMENT FOR
CRYOSTATIC VESSEL

CLAIM FOR PRIORITY UNDER 35 U.S.C. §119


Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The benefit of the filing date of prior foreign application No. 0227067.6, filed in Great Britain on November 20, 2002, is hereby requested and the right of priority under 35 U.S.C. §119 is hereby claimed.

In support of this claim, filed herewith is a certified copy of the original foreign application.

Respectfully submitted,


Gary R. Edwards
Registration No. 31,824

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INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation and Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein together with the Statement of inventorship and of right to grant of a Patent (Form 7/77), which was subsequently filed.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

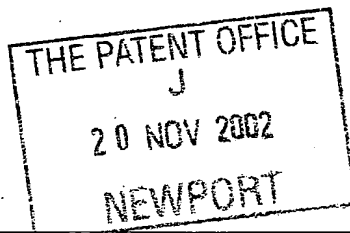
Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed 

Dated 20 November 2003

Request for grant of a patent

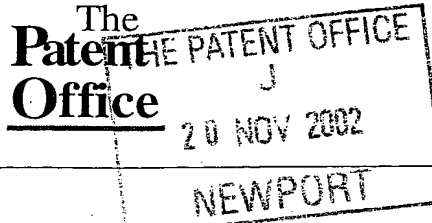
(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)



The Patent Office

Cardiff Road
Newport
Gwent NP10 8QQ

1. Your reference	2002P18965 GB / P72 / CF / GD		
2. Patent application number (The Patent Office will fill in this part)	<div style="text-align: right;">20 NOV 2002</div> <div style="text-align: center; font-size: 1.5em;">0227067.6</div>		
3. Full name, address and postcode of the or of each applicant (underline all surnames)	OXFORD MAGNET TECHNOLOGY LTD. WHARF ROAD, EYNHAM OXFORD OX8 1BP		
Patents ADP number (if you know it) 647776002 If the applicant is a corporate body, give the country/state of its incorporation	UNITED KINGDOM		
4. Title of the invention	INTEGRATED RECONDENSING COMPACT PULSE TUBE REFRIGERATOR		
5. Name of your agent (if you have one) "Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)	Siemens PLC Intellectual Property Department The Lodge, Roke Manor Romsey, Hampshire SO51 0ZN		
Patents ADP number (if you know it) 6338180001			
6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each these earlier applications and (if you know it) the or each application number	Country	Priority application number (if you know it)	Date of filing (day / month / year)
7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application			
8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if: a) any application named in part 3 is not an inventor, or b) there is an inventor who is not named as an applicant, or c) any named applicant is a corporate body.	Yes		



See note (d))

9. Enter the number of sheets for any of the following items you are filling with this form. Do not count copies of the same document

Continuation sheets of this form

Description	3
Claim(s)	0
Abstract	0
Drawing(s)	0

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translation of priority documents

Statement of inventorship and right to grant a patent (Patents Form 7/77) 1

Request for preliminary examination and search (Patents Form 9/77)

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application

Signature Date

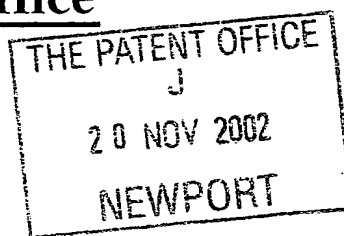
Clive French 19.11.2002
Intellectual Property Department

12. Name and daytime telephone number of Person to contact in the United Kingdom

Clive French + 44 1794 83 3573

**Statement of inventorship and of
right to grant of a patent**

(See the notes on the back of this form)



The Patent Office

Cardiff Road
Newport
Gwent NP10 8QQ

1. Your reference

2002P18965 GB / P72 / CF / GD

2. Patent application number
(If you know it)

0227067.6

20 NOV 2002

3. Full name of the or of each applicant

OXFORD MAGNET TECHNOLOGY LTD.
WHARF ROAD, EYNHAM
OXFORD OX8 1BP

4. Title of the invention

INTEGRATED RECONDENSING COMPACT PULSE
TUBE REFRIGERATOR

5. State how the applicant(s) derived the right
from the inventor(s) to be granted a patent

By provisions of contract of service and Section 39(1)
(a) and (b) of the Patent Act 1977.

6. How many, if any, additional Patents Forms
7/77 are attached to this form?
(see note (c))

None

7.

I/We believe that the person(s) named over the page
(and on any extra copies of this form) is/are the
inventor(s) of the invention which the above patent
application relates to.

Signature

Date

Clive French
Intellectual Property Department

19.11.2002

8. Name and daytime telephone number of
person to contact in the United Kingdom

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Enter the full names, addresses and postcodes of the inventors in the boxes and underline the surnames

	<p>1) <u>Daniels</u> Peter Derek 7 Willow Close Woodford Halse, Daventry, Northants NN11 3RZ UNITED KINGDOM</p>
	<p>Patents ADP number <i>(if you know it)</i>:</p> <p>2)</p>
	<p>Patents ADP number <i>(if you know it)</i>:</p> <p>3)</p>
	<p>Patents ADP number <i>(if you know it)</i>:</p> <p>4)</p>
	<p>Patents ADP number <i>(if you know it)</i>:</p> <p>5)</p>
	<p>Patents ADP number <i>(if you know it)</i>:</p> <p>6)</p>

Patent Outline – Integrated recondensing PTR-compact version

Summary

Pulse Tube Refrigerators (PTR's) are an effective method of producing cooling at cryogenic temperatures and can be applied to a diverse range of applications where cryogenic cooling is required. Single or multiple stage cooling devices can be used to assist conservation of liquid cryogenics. In applications like MRI, NMR and other large scale uses of superconducting magnets it is desirable to reduce the consumption of the cryogenic liquid, usually liquid helium cooling the magnet. Other cryogenic liquids are used for high temperature superconducting magnet systems. During operation of the PTR heat is extracted from the magnet system at the low temperature heat stations and rejected at a higher temperature heat station through heat exchangers. The principle of operation of PTR systems is comprehensively reported in technical literature. In applications such as MRI it is desirable to reduce parasitic heat loads to a minimum so that the refrigerator used to cool the system can be of minimum size. 4-valve PTR systems in particular feature a very compact design as compared with other PTR designs (see also four-valve PTR 1993, 4th joint-sino-Japanese Seminar (Matsubara) This publication mentions compactness, I believe the first time. The compactness may be a prerequisite for fitting into a small turret since it has no buffer volume that has to be accommodated. Traditionally the refrigerator is inserted into the cryostat in a separate receptacle to the one which is used to service the liquid cryogen and current leads. In the case of a 4K refrigerator it is required that the refrigerator is in intimate contact with the helium gas in order that recondensation can take place.

The invention described here shows how an integrated design solution exists which minimises the parasitic heat loads on the system.

The proposed solution differs from existing practice because the helium neck tube is either larger to accept the size of the refrigerator incorporating helium services like fill, current lead access etc, or there are two tubes, one to accept the refrigerator, the other as a helium service neck.

PTR system components and operation relating to this patent.

The following diagram shows typical components in a PTR refrigeration system in a magnet system showing names of parts for use in the later descriptions.

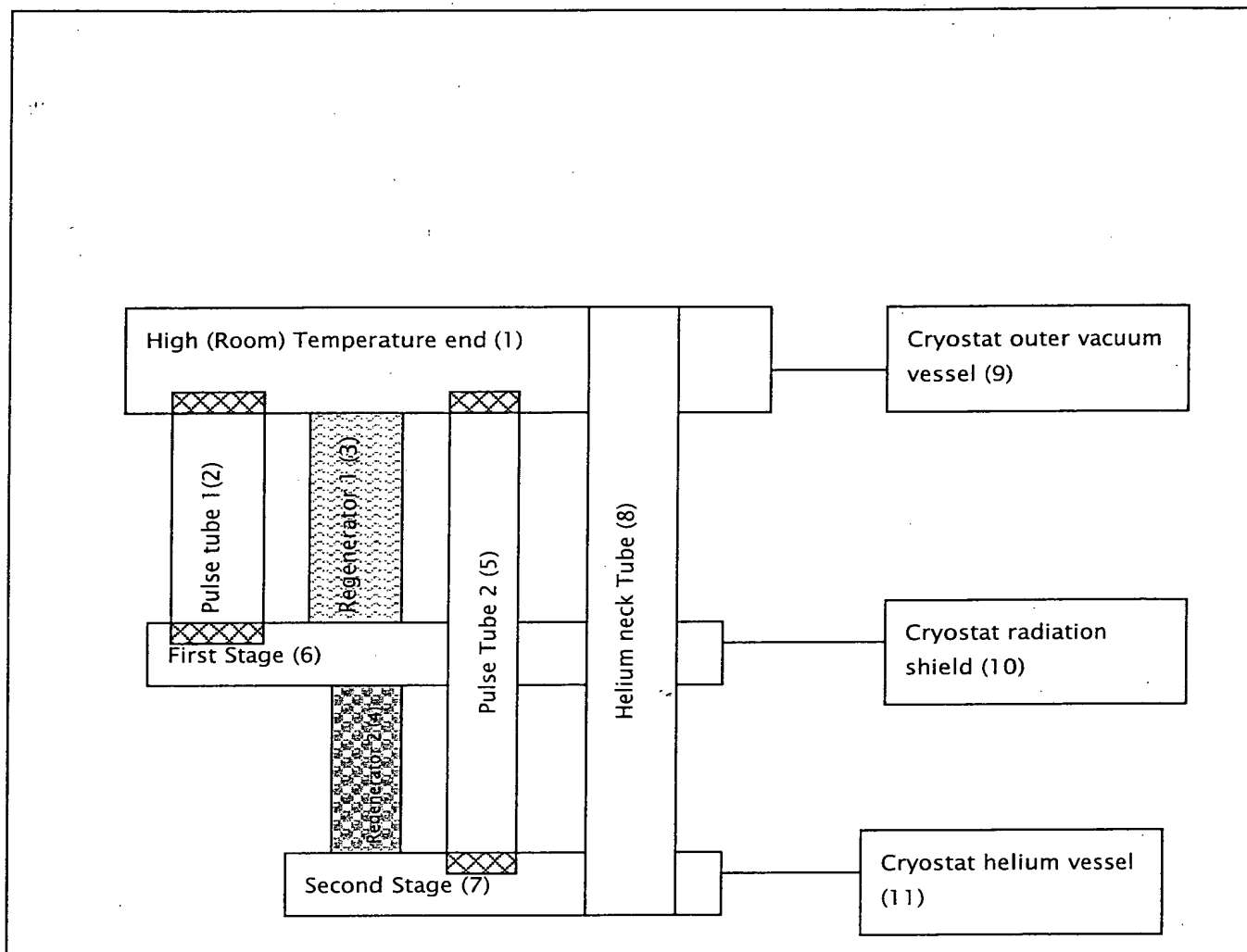


Figure 1 –System configuration of a two stage integrated recondensing PTR

An integrated 4K PTR and helium service assembly is proposed as items (1) – (7) inclusive which is incorporated in a helium cryostat with vacuum vessel (9), Radiation shield (10) and helium vessel (11) containing the superconducting magnet. In this arrangement the helium neck tube (8) is integrated into the assembly. The advantage of this arrangement over other schemes is that the helium neck tube is a small tube attached to the PTR assembly. The Helium neck tube (8) which carries helium fill, current lead and other necessary services to ensure that the magnet in the helium vessel (11) is able to be operated safely is of a reduced size. The size of this tube can be reduced in this case because the PTR does not need to fit within the tube and it can be sized based on safe venting of the liquid helium, typically requiring. The smaller size of this tube minimises the parasitic heat loads on the system and makes the arrangement simpler. In addition the PTR (1)-(7) is fitted in the cryostat vacuum space such that no additional material is required to separate the PTR tubes (2)-(5) from the gas that would be present in a larger diameter neck tube (not shown) that would fit the PTR within it. Further the insulating vacuum is provided by the main cryostat vacuum which surrounds the PTR tubes (2)-(5), no additional vacuum insulation is required. Use of the main cryostat vacuum to insulate the PTR tubes (2)-(5) provides an excellent high quality vacuum because the helium vessel acts as a very large cryopump when it is filled with liquid helium. Connection of the cooling stages (6) and (7) to the neck tube (8) is by use of high conductivity permanent metal joint from the high conductivity stage material to the neck tube. At the second stage(7) which is close to or part of the helium vessel (11) 4K recondensation of helium will occur on the surfaces of the stage that are exposed to helium gas.

TR is safe in terms of a quench or other faults. PTR does not need any sleeves or other insulation since it is located in the vac space around the neck tube. Gives a cost benefit – and a gain enables compact design. The PTR around the neck gives the designer the freedom to locate the tubes around the neck tube conveniently so that the tubes are not touching each other and above all superinsulation can be applied to the PTR or being part of the superinsulation of the shields which again reduces losses and improves performance.

There is a benefit if the pulse tube is directly contacted to the shield stages – even more important for a 4 K cooler. With a 4 K cooler the 2nd stage liquefaction surface could actually be the necks (bottom end vertical finned arrangement). The direct contact with the shields again reduces losses considerably.

Peter Daniels

Wolfgang Stautner

3/9/02

